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NOTES ON GEOGRAPHIC DISTRIBUTION

Lindernia rotundifolia (Linderniaceae), *Picria fel-terrae* (Linderniaceae), and *Limnophila aromatica* (Plantaginaceae): three new records for the flora of Nepal

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Abstract. *Lindernia rotundifolia* (L.) Alston (Linderniaceae), *Picria fel-terrae* Lour. (Linderniaceae), and *Limnophila aromatica* (Lam.) Merr. (Plantaginaceae) are newly reported from Jalthal forest, eastern Nepal. *Picria* Lour. is a new generic record for Nepal. Descriptions of all the species based on Nepalese specimens are provided, along with notes on diagnostic features, color photographs of the species, distribution maps, and notes on habitats.

Key words. Floristic survey, Jalthal forest, Jhapa district, lowland Nepal, remnant forest, taxonomy

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INTRODUCTION

The botanical exploration in Nepal began in the early 19th century with the collections of Francis Buchanan-Hamilton, Edward Gardner, and Nathaniel Wallich (Rajbhandari 2016). Since then, botanical exploration has continued, primarily focusing on the mid Hills and the high Himalaya, while the lowland flora of Nepal remains little explored (Pendry et al. 2015; Rajbhandari 2016).

Jalthal forest, a lowland forest in southeast Nepal, covers an area of about 6,000 ha in a human-dominated landscape. It is a remnant of what in earlier times was a dense, widespread, and continuous forest known as *Charkoshe Jhadi*, mostly harboring Indo-Malayan floristic elements (Thapa et al. 2003). In recent years, attempts have been made to explore the biodiversity of Jalthal forest and adjoining areas, resulting in reports of noteworthy flowering plants for Nepal (Sharma et al. 2020; Bhandari et al. 2021; Sharma and Adhikari 2021; Sharma et al. 2021; Poudel et al. 2021; Adhikari et al. 2023). This study further contributes to the lowland flora with the addition of three species, namely *Lindernia rotundifolia* (L.) Alston, *Picria fel-terrae* Lour., and *Limnophila aromatica* (Lam.) Merr., to the flora of Nepal. All the three species were previously classified under Scrophulariaceae; however, recent molecular systematic studies (Rahmanzadeh et al. 2005; Schäferhoff et al. 2010; Fischer et al. 2013) have placed *Lindernia* All. and *Picria* Lour. in Linderniaceae, and *Limnophila* R.Br. in Plantaginaceae.

Linderniaceae are dominant in tropical Africa, Madagascar, and tropical Asia and Australia, and just a few members occur in tropical America (Fischer et al. 2013; Biffin et al. 2018). *Picria*, a monotypic genus, is represented by *Picria fel-terrae* Lour. and is characterized by four unequal sepals in two series. *Lindernia*, with about 65 species worldwide (Plants of the World Online 2024), is difficult to delimit taxonomically by morphology, but palmate leaf venation and seeds with smooth endosperm are considered useful characters (Fischer et al. 2013). In Nepal, Linderniaceae is represented by six genera and 21 species (Rajbhandari et al. 2022; Shrestha et al. 2022), including two species of *Lindernia*: *Lindernia parviflora* (Roxb.) Haines and *Lindernia procumbens* (Krock.) Philcox.

Globally, *Limnophila* comprises 35–45 species (Philcox 1970; Hong et al. 1998; Plants of the World Online 2024), which are distributed in tropical and subtropical regions of the Old World, with tropical Asia as the center of diversification (Philcox 1970). It can be distinguished from other genera by the characteristic opening of a capsule into two or four valves, leaving the septum entire at least at the base, bearing the placentas on the faces and forming two wings to the undivided placental column (Philcox 1970). In Nepal, Plantaginaceae is represented by 53 species in 19 genera (Rajbhandari et al. 2022; Shrestha et al. 2022), including seven species of *Limnophila*: *L. chinensis* (Osbeck) Merr., *L. connata* (Buch.-Ham. ex D.Don)

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Hand.-Mazz., *L. heterophylla* (Roxb.) Benth., *L. indica* (L.) Druce, *L. repens* (Benth.) Benth., *L. rugosa* (Roth) Merr., and *L. sessiliflora* (Vahl) Blume.

METHODS

This study is based on the floristic survey of the Jalthal forest conducted during multiple visits between January 2020 and July 2022 for the exploration of the flowering plants of the area. The forest is mostly dominated by *Shorea robusta* C.F. Gaertn., although it also has tropical evergreen forest patches along moist gullies. The specimens were collected from moist and wet habitats in the forest, using standard methods following Bridson and Forman (1992), and detailed photographs were taken for further studies. The coordinates of the collection locations were recorded using a GPS receiver (Garmin eTrex 10). Detailed examination of the collected specimens revealed that the species were *Lindernia rotundifolia* (L.) Alston (Linderniaceae), *Picria fel-terrae* Lour. (Linderniaceae), and *Limnophila aromatica* (Lam.) Merr. (Plantaginaceae). Relevant literature like Philcox (1970), Hara (1982), Hong et al. (1998), Fischer (1999), Press et al. (2000), Mill (2001), Liang et al. (2012), Rajbhandari et al. (2022), and Shrestha et al. (2022) were consulted to validate the identification and new record information. The identification was further confirmed by comparing our specimens with the herbarium specimens at the Royal Botanic Garden Edinburgh (**E**). A map showing the global distribution of each species was prepared based on occurrence data available at the Global Biodiversity Information Facility (GBIF, https://www.gbif.org/), data from some other sources, including the distribution maps at Plants of the World Online (https://powo.science.kew.org/), distribution information on major floras of adjacent regions (Hooker 1885; Hong et al. 1998; Mill 2001), specimens examined at the Royal Botanic Garden Edinburgh (E), and data from our own collections. Since the location data derived from floras and some specimens at the Royal Botanic Garden Edinburgh herbarium (E) lacks exact coordinates, the occurrence points are estimated using the provided locality information. GeoCAT (Geospatial Conservation Assessment Tool; https://geocat.iucnredlist.org/) was used to import and download occurrence data from GBIF. The GBIF occurrence data were all checked and cleaned before preparing the map. All specimens collected during the study are deposited at the Tribhuvan University Central Herbarium (**TUCH**) and the National Herbarium and Plant Laboratories (**KATH**).

RESULTS

Here we report new records for three herb species: *Lindernia rotundifolia* (L.) Alston, *Picria fel-terrae* Lour. and *Limnophila aromatica* (Lam.) Merr. for the flora of Nepal.

***Lindernia rotundifolia* (L.) Alston**, Handb. Fl. Ceylon 6(suppl.): 214 (Alston 1931)
Basionym: *Gratiola rotundifolia* L., Mant. Pl. Altera 2: 174 (Linnaeus 1771)
Figure 1

New records. NEPAL – Koshi • Jhapa district, Bhadrapur municipality, Jalthal, Rangedada; 26.521, 088.047; 70 m alt.; 11.II.2020; Y.B. Poudel leg.; 1 spec., KATH JF274 • same locality; 16.III.2021; Y.B. Poudel leg.; 2 spec., KATH, TUCH JF156.

Identification. Herbs, diffuse. Stem 4–25 cm, branched, creeping or decumbent, rooting from lower nodes, quadrangular, glabrous. Leaves sessile, exstipulate, opposite, ovate or orbicular, 3–16 × 3–16 mm, base rounded or broadly cuneate, apex obtuse or rounded, margin sub-entire to serrate, 2–3 teeth on each side of midrib, both surfaces glabrous, glandular-punctate, palmately veined, secondary veins 1–2 on each side of midrib. Flowers solitary axillary; pedicels 4–6 mm, to 8 mm in fruit, stipitate-glandular. Calyx 5-lobed, lobes ovate, 2–4 mm, sub-equal, densely stipitate-glandular. Corolla white with blue blotches, 11–12 mm long, 2-lipped; lower lip 3-lobed, broadly obovate, ca. 4 × 9 mm, glabrous; upper lip 2-lobed, ovate, ca. 3 × 2.5 mm, glabrous; tube funnelform, 7–8 mm, white, pubescent at mouth, sparsely stipitate-glandular outside. Stamens 4; anterior 2 stamens reduced to clavate staminodes, exerted from the corolla tube; filaments 5–6 mm, scaly, yellow; antherodes blue; posterior 2 stamens fertile, included in corolla tube; filaments 1.3–1.5 mm, geniculate, glabrous; anthers coherent, divaricate. Pistils 6–7 mm, glabrous; ovary ovoid, ca. 2 mm, green; style ca. 4 mm, white; stigma bilamellate. Capsules ovoid or ellipsoid, 2.5–4 × 2–3 mm, glabrous, green.

Lindernia rotundifolia is distinct from two recorded species in Nepal, *L. procumbens* (Krock.) Philcox and *L. parviflora* (Roxb.) Haines, in its stipitate-glandular pedicels and calyces, and corollas that are more than 10 mm long. *Lindernia procumbens* and *L. parviflora* have eglandular pedicels and calyces, and corollas that are less than 10 mm long.

Habitat and distribution. The species was found growing on sandy soil along river banks and in moist places at the forest margin. It is distributed in Africa, Central and South America, India, Nepal (present record) and Sri Lanka (Figure 2). The species is reported as a naturalized species in Taiwan (Liang et al.

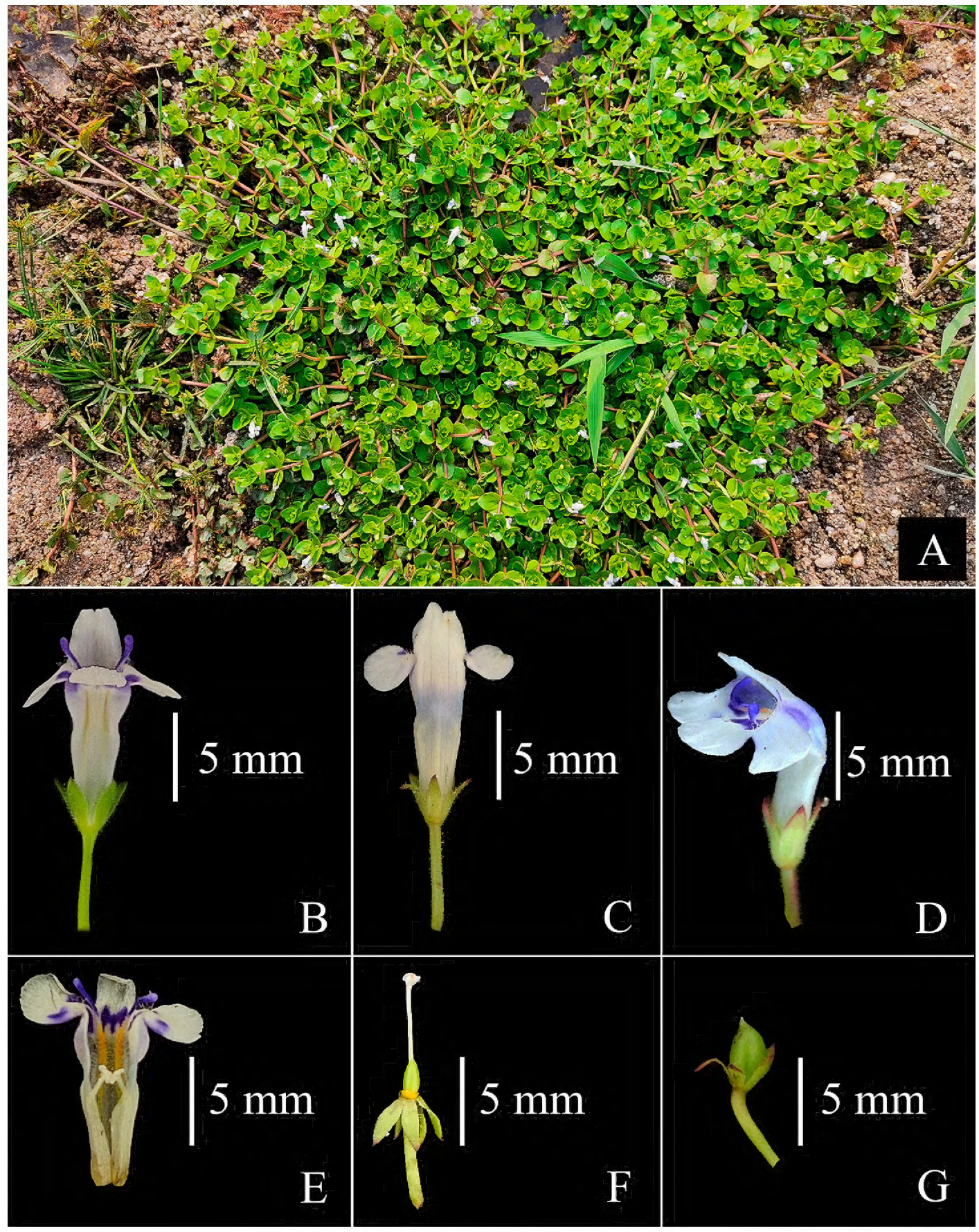

Figure 1. *Lindernia rotundifolia* (L.) Alston. **A.** Habit. **B, C.** Flower, side views. **D.** Flower, frontal view showing blue antherodes. **E.** Open corolla showing fertile stamens and staminodes. **F.** Pistil with calyx moved downwards. **G.** Fruit with persistent calyx.

2012) and Australia (Wannan 2019). In Nepal, it is currently known to occur only in Jalthal forest, Jhapa district, in southeast Nepal (Figure 3).

Flowering and fruiting. January to September.

***Picria fel-terrae* Lour.**, Fl. Cochinch. 2: 393 (Loureiro 1790)
Figure 4

New records. NEPAL – Koshi • Jhapa district, Bhadrapur municipality, Jalthal, Kutuni Khola; 26.50, 088.03; 100 m alt., 18.XI.2020; Y.B. Poudel leg.; 2 spec., KATH, TUCH JF724 • same locality; 12.VII.2022, Y.B. Poudel, B. Adhikari, L.N. Sharma and G. Parmar leg.; 2 spec., KATH YBLG01.

Identification. Herbs, diffuse. Stem up to 70 cm long, branched, decumbent, rooting from lower nodes, angular in cross section, pubescent. Petioles 2–25 mm, pubescent. Leaves exstipulate, opposite, ovate or elliptic, 2.1–5.6 × 1.3–4.1 cm, base obliquely cuneate, apex obtuse or subacute, margin crenate or serrate with small trichomes, upper surface minutely pubescent, lower surface hispid, mainly on veins, pinnately veined, secondary veins 5–6 on each side of midrib. Flowers in terminal and axillary racemes, 2–8 flowers per raceme; peduncle 2.2–2.7 cm, quadrangular, pubescent; pedicels 5–16 mm, apex dilated, winged, pubescent. Bracts lanceolate, ca. 3.5 × 2 mm, base truncate, apex acute, margin entire with minute trichomes. Calyx 4-lobed in 2 series, divided near to base, outer 2 large; outer upper lobe larger than lower, ovate, up to 17 × 13 mm in fruit, base cordate, apex rounded, margin entire with minute trichomes, glabrous, palmately veined; outer lower lobe ovate, up to 13 × 10 mm in fruit, base broadly cordate or rounded, apex

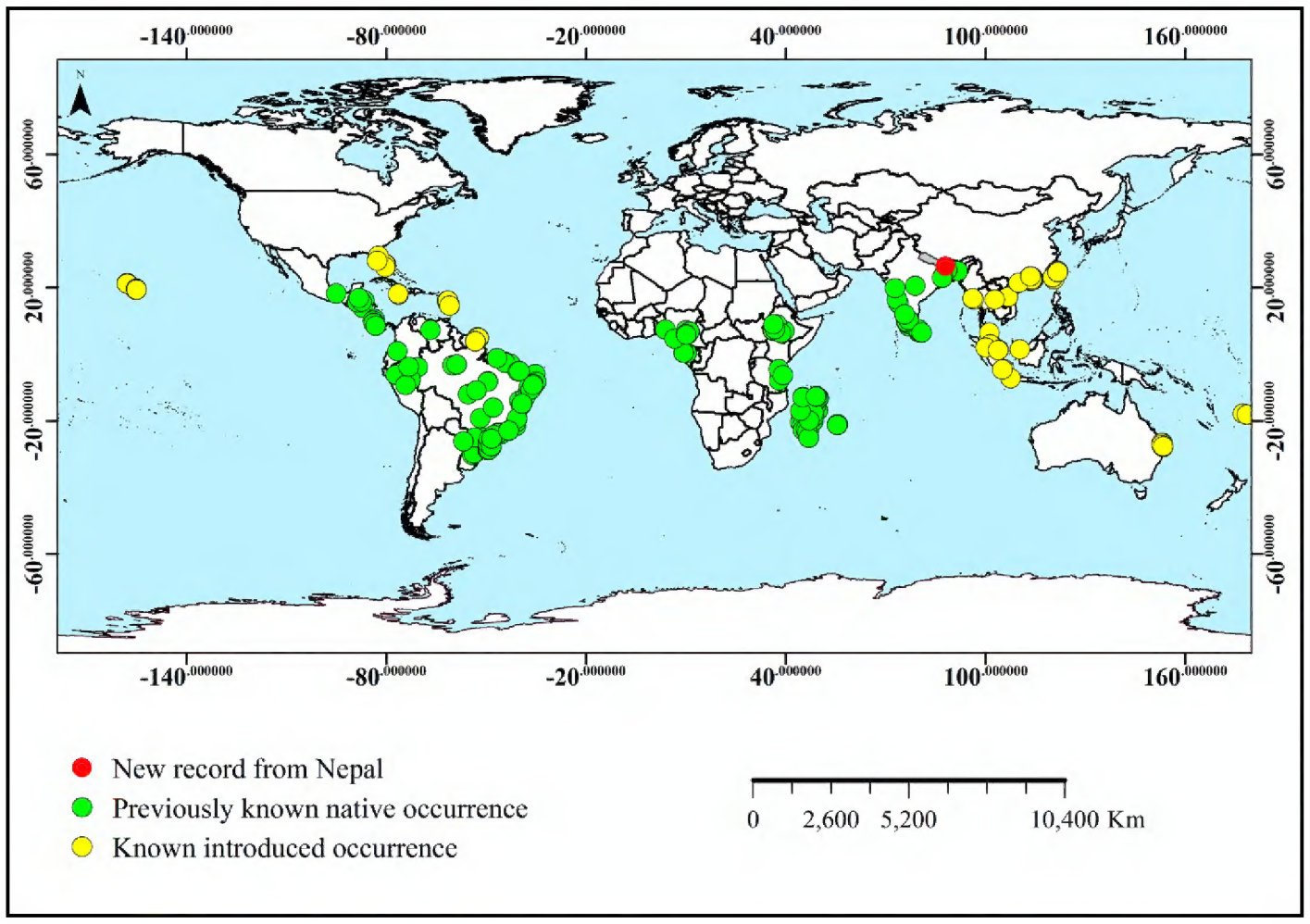

Figure 2. Global distribution of *Lindernia rotundifolia* (L.) Alston.

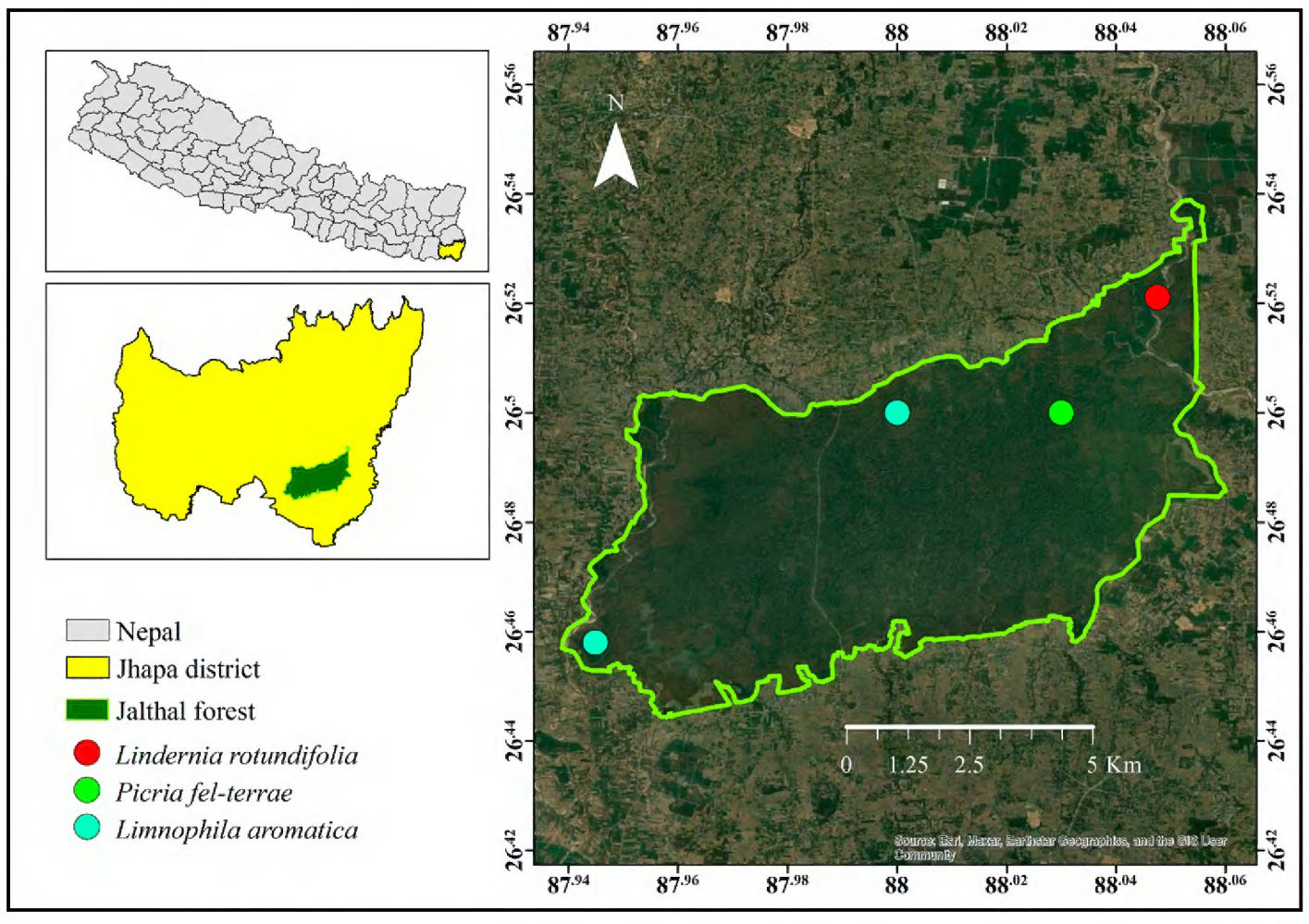

Figure 3. Occurrence of *Lindernia rotundifolia*, *Picria fel-terrae*, and *Limnophila aromatica* in Jalthal forest, Jhapa district, Nepal.

notched, margin entire with minute trichomes, glabrous, palmately veined; inner lateral lobes 2, linear, curved, ca. 8.5 × 1.5 mm, margin entire with minute trichomes, mid-vein with minute trichomes. Corolla white, 11–12.5 mm long, 2-lipped; lower lip 3-lobed, broadly obovate, 5.5–6.5 mm, glabrous; upper lip 4–4.5 mm, narrower, ligulate, apex undulate, with purple longitudinal veins, glabrous; tube 5–6.5 mm, reddish-brown, constricted at middle, glandular outside. Stamens 4; anterior 2 stamens reduced to clavate staminodes, exserted from corolla tube; filaments ca. 6 mm, pubescent, hairs yellow; antherodes yellow; posterior 2 stamens fertile, included in corolla tube; filaments ca. 2 mm, geniculate, glabrous; anthers coherent, divaricate. Pistil ca. 8 mm, glabrous; ovary ovoid, ca. 2 mm, green; style ca. 5 mm, white; stigma bilamellate. Capsules ovoid, 5–7 × 4–5 mm, glabrous, green.

Picria fel-terrae can be easily distinguished from other Linderniaceae species in Nepal by its two series of four sepals with unequal width (Figure 4C–E).

Habitat and distribution. A small patch of wild population growing on sandy soil was recorded from only one location in an evergreen strip of forest along the moist gullies. It is distributed in Bangladesh, China,

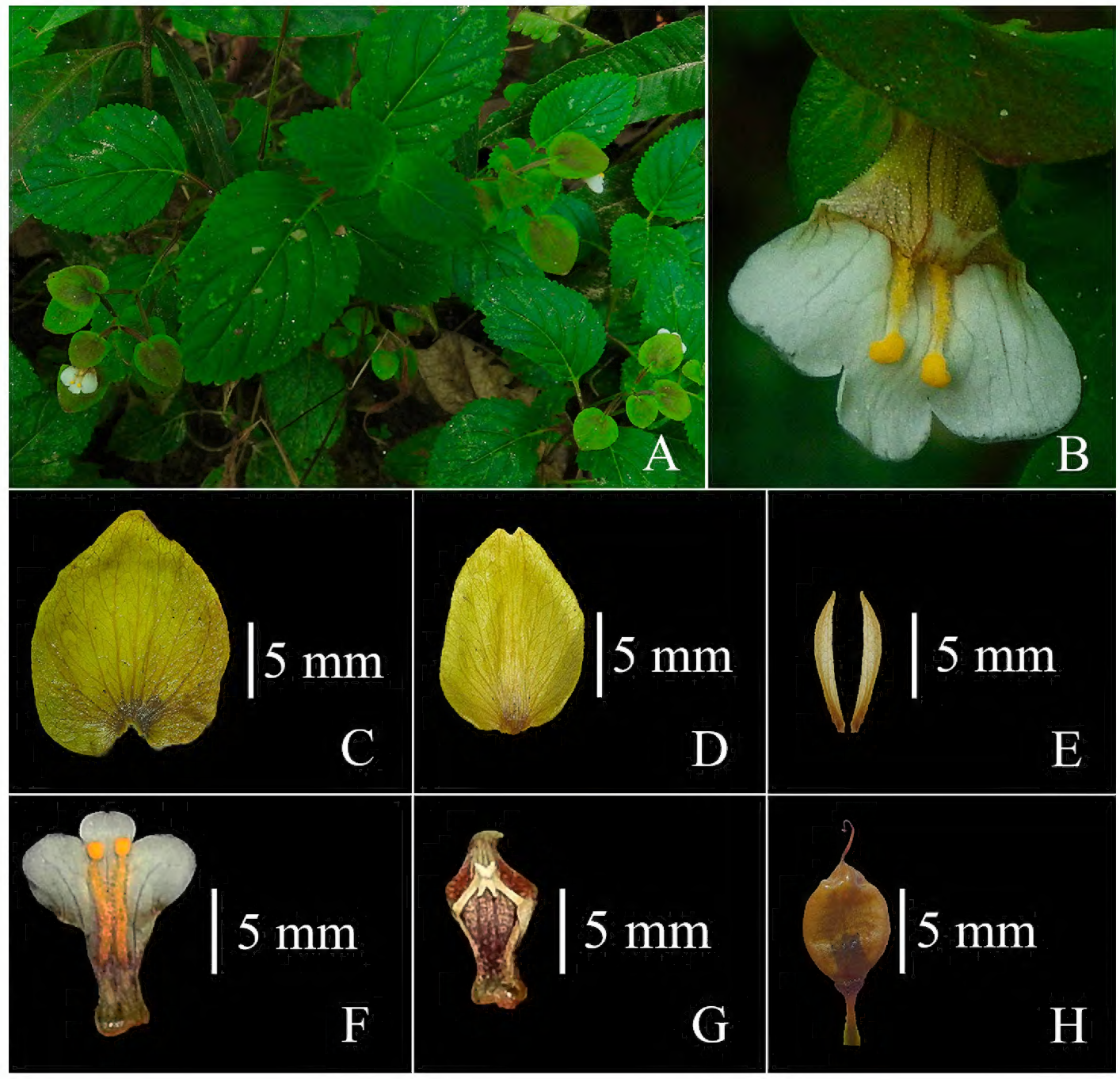

Figure 4. *Picria fel-terrae* Lour. **A.** Habit. **B.** Flower. **C.** Outer upper calyx lobe. **D.** Outer lower calyx lobe. **E.** Inner lateral calyx lobes. **F.** Open corolla showing lower lip and staminodes. **G.** Open corolla showing upper lip and fertile stamens. **H.** Fruit.

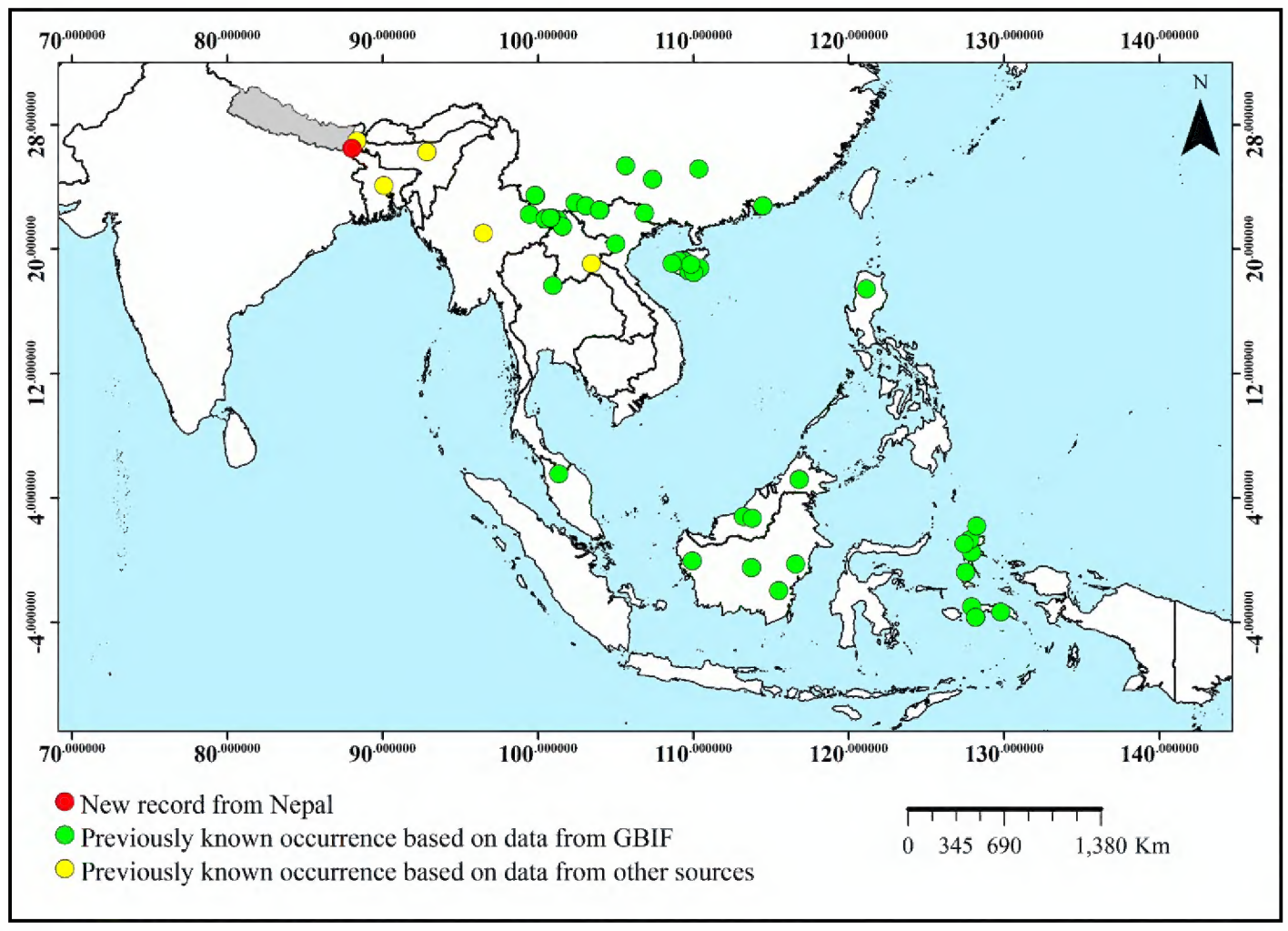

Figure 5. Global distribution of *Picria fel-terrae* Lour.

India, Indonesia, Laos, Malaysia, Myanmar, Nepal (present record), Philippines, Thailand and Vietnam (Figure 5). In Nepal, it is currently known to occur only in Jalthal forest, Jhapa district, in southeast Nepal (Figure 3).

Flowering and fruiting. July to November.

***Limnophila aromatica* (Lam.) Merr.**, Interpr. Herb. Amboin.: 466 (Merrill 1917)
Basionym: *Ambulia aromatica* Lam., Encycl. 1: 128 (Lamarck 1783)
Figure 6

New records. NEPAL – Koshi • Jhapa district, Haldibari rural municipality, Jalthal, Pathivara Kalika; 26.51, 088.00; 80 m alt.; 04.XI.2020; Y.B. Poudel leg.; 1 spec., KATH JF529 • Jhapa district, Barhadashi rural municipality, Jalthal, Sadhuprati; 26.458, 87.944, 70 m alt.; 10.XI.2020; Y.B. Poudel leg.; 1 spec., KATH, TUCH JF615.

Identification. Herbs, diffuse. Stem up to ca. 50 cm tall, unbranched or branched, erect or ascending, if ascending rooting from lower nodes, terete, minutely glandular. Leaves sessile, exstipulate, opposite or in whorls of 3, ovate-lanceolate or lanceolate-elliptic, 20–80 × 4–15 mm, base semi-amplexicaul, apex acute, margin serrate or serrate-dentate, both surfaces gland-dotted, pinnately veined. Flowers in terminal and/

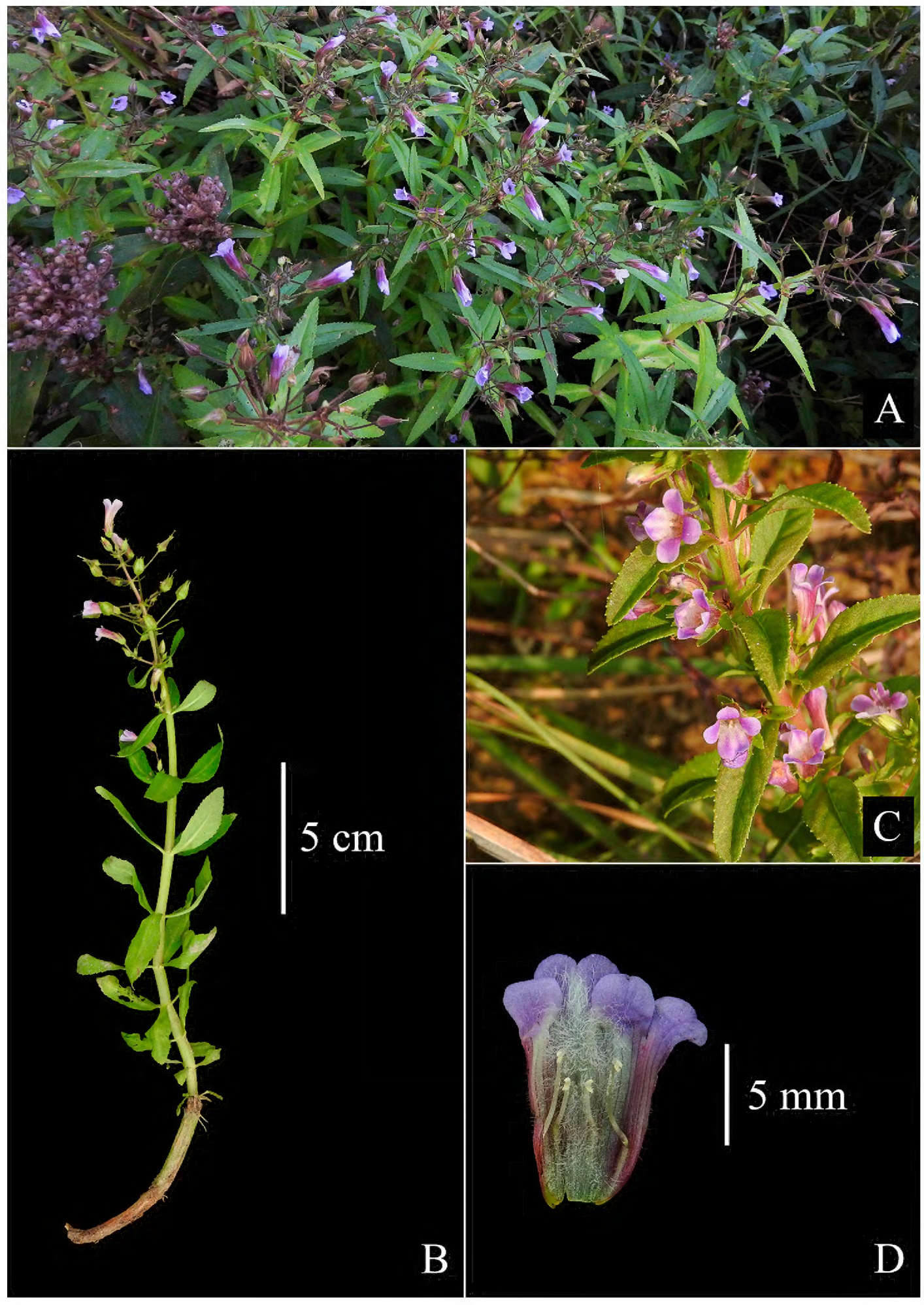

Figure 6. *Limnophila aromatica* (Lam.) Merr. **A.** Habit. **B.** Flowering plant. **C.** Flowering branch. **D.** Open corolla showing stamens.

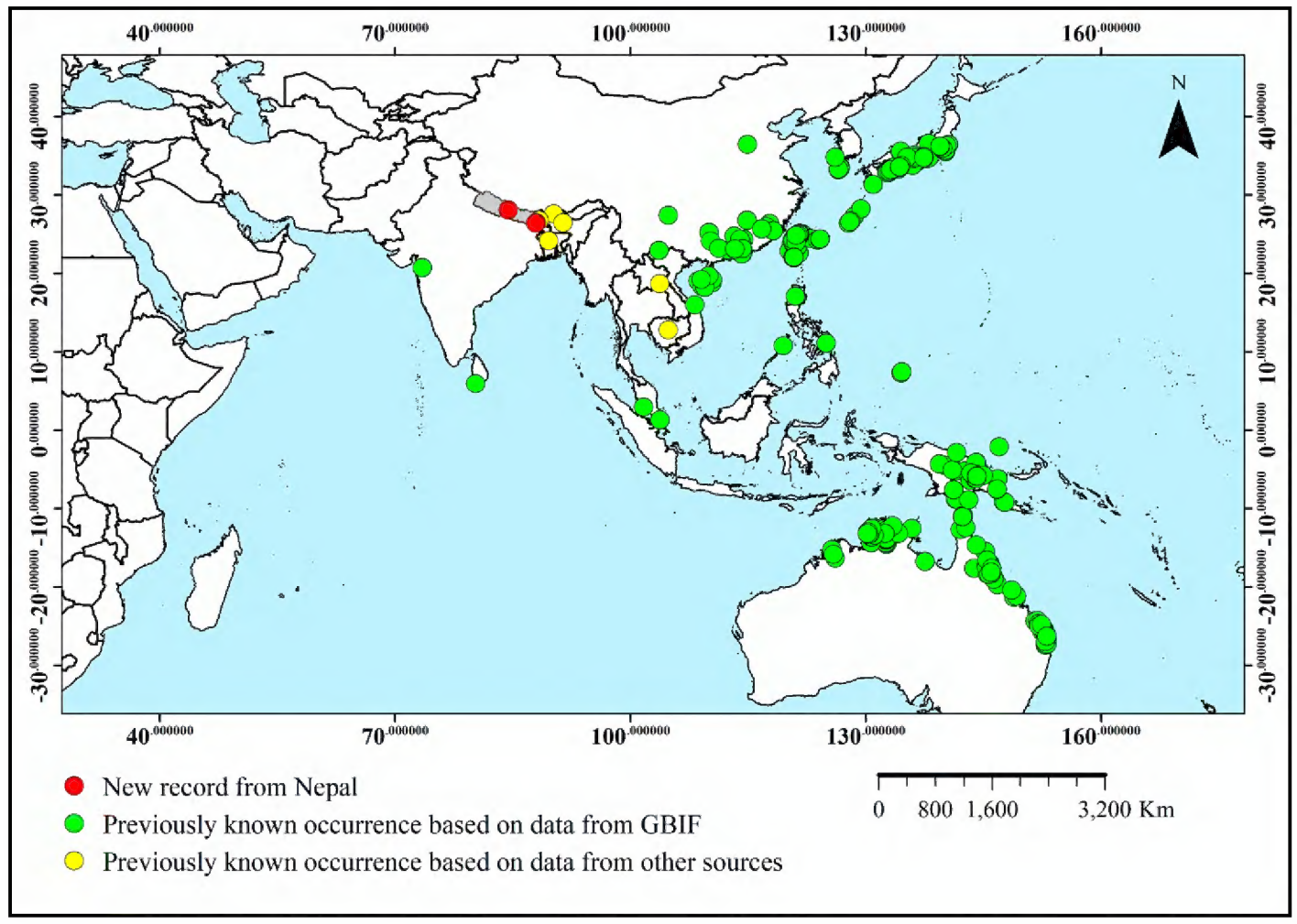

Figure 7. Global distribution of *Limnophila aromatica* (Lam.) Merr.

or axillary racemes or sometimes solitary axillary; pedicels 5–10 mm, extending up to 20 mm in fruit, stipitate-glandular. Bracteoles 2 at base of calyx, linear, 1.5–2 mm. Calyx campanulate, with many longitudinal veins at maturity; lobes 5, lanceolate, 3–4 mm, enlarged to 4–7 mm in fruit, equal, glandular; tube ca. 1–1.5 mm. Corolla purple, 10–14 mm long, stipitate-glandular outside, long-villous inside, 2-lipped; lower lip 3-lobed, spreading; upper lip 2-lobed; tube tubular, 7.5–9 mm. Stamens 4, all fertile, didynamous, included in corolla tube; anterior filaments ca. 4 mm, glabrous, white; posterior filaments ca. 2.5 mm, villous, white. Pistil ca. 7 mm, glabrous; ovary ovoid, ca. 2 mm, green; style filiform, deflexed at apex, ca. 5 mm, white; stigma bilamellate. Capsules ovoid, compressed, 4.5–7 mm, glabrous, brown.

Limnophila aromatica can be easily distinguished from other recorded species in Nepal by a combination of following characters: stem minutely glandular, absence of finely divided submerged leaves, leaves opposite or in whorls of 3, mature calyx with more than 5 prominent longitudinal veins and corolla usually more than 10 mm long (Philcox 1970). The plant is strongly aromatic when crushed.

While studying the herbarium specimens at the Royal Botanic Garden Edinburgh (E), we found a specimen of *Limnophila aromatica*, E00992922, collected in 1981 by John David Adam Stainton from the edge of rice fields in Tarughat, central Nepal. However, it has not been published or reported from Nepal to date. This specimen does not have geographic coordinates but the data includes a textual description of the location. The occurrence record of this species in central Nepal is presented in Figure 7 based on the textual description of the location.

Habitat and distribution. It is commonly found in marshes and riverbanks in the forest. It is distributed in Australia, Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Japan, Laos, Malaysia, Nepal (present record), Papua New Guinea, Philippines, South Korea, Sri Lanka, Taiwan, and Vietnam (Figure 7). In Nepal, it is currently known to occur in Jalthal forest, Jhapa district, in southeast Nepal (Figure 3) and Tarughat, Lamjung district, central Nepal.

Flowering and fruiting. October to December.

DISCUSSION

New records of *Lindernia rotundifolia* and *Picria fel-terrae* bring the number of genera to seven and species to 23 in Linderniaceae in Nepal. *Picria* is a new generic record for the flora of Nepal. Furthermore, this present record of *Limnophila aromatica* makes the number of species to 54 in Plantaginaceae in Nepal. Our findings extend the known geographical distribution of *Lindernia rotundifolia*, *Picria fel-terrae*, and *Limnophila aromatica*. This also demonstrates the importance of floristic surveys in the lowlands of Nepal to contribute to the documentation of Nepalese flora.

The previously recorded nearest occurrence point (Raijung, West Bengal, India; Global Biodiversity Information Facility 2024) of *Lindernia rotundifolia* is about 99 km southeast of the present collection in Jalthal forest, measured as the aerial distance. Similarly, the previously recorded nearest location of *Picria fel-terrae* is Mangpu, Darjeeling, West Bengal, India (Mill 2001), which is about 60 km away in a straight line to the northeast from the present record.

Although *Limnophila aromatica* has been collected as early as 1981 by John David Adam Stainton from central Nepal, about 392 km northwest from a collection point at Jalthal forest, it has not been reported from Nepal. This species has been overlooked for so long. This might be due to limited botanical explorations in Nepal's lowlands (Pendry et al. 2015; Rajbhandari 2016). *Limnophila aromatica* might occur in similar habitats between the known range in Nepal, which can be confirmed by further botanical exploration in the understudied regions, especially the lowlands. The previously recorded nearest location (Sukna, Darjeeling, West Bengal, India; Mill 2001) of *L. aromatica* is about 50 km northeast of the current record, measured as the aerial distance.

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ADDITIONAL INFORMATION

Conflict of interest

The authors declare that no competing interests exist.

Ethical statement

No ethical statement is reported.

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Author contributions

Conceptualization: YBP, KP, BA, SR. Data curation: YBP, KP, BA. Formal analysis: YBP, KP, BA. Funding acquisition: YBP, BA. Investigation: YBP, KP, BA. Methodology: YBP, KP, BA, SR. Resources: YBP, KP, BA, SR. Supervision: BA, SR. Visualization: YBP, KP, BA, SR. Project administration: YBP, BA. Validation: YBP, KP, BA, SR. Writing – original draft: YBP. Writing – review and editing: YBP, KP, BA, SR.

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Data availability

All data that support the findings of this study are available in the main text.

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